

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
Office of Engineering and Technology Invites)	
Comments on Technological Advisory Council)	ET Docket No. 13-101
(TAC) White Paper and Recommendations for)	
Improving Receiver Performance)	

COMMENTS OF THE GPS INNOVATION ALLIANCE

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COMMENTS OF THE GPS INNOVATION ALLIANCE

The GPS Innovation Alliance (“GPSIA”) hereby submits these comments in response to the Public Notices issued by the Office of Engineering and Technology (“OET”) seeking comment on the White Paper prepared by the FCC’s Technological Advisory Council (“TAC”)^{1/} analyzing the role of receivers in efficient spectrum use and providing recommendations on methods for improving spectral efficiency.^{2/}

I. INTRODUCTION AND SUMMARY

The GPSIA was formed in February 2013 to protect, promote, and enhance the use of Global Positioning System (“GPS”) and Global Navigation Satellite System (“GNSS”) technologies. Members and affiliates of the GPSIA are drawn from a wide variety of fields and businesses reliant on GPS, including manufacturing, aviation, agriculture, construction, transportation, first responders, surveying, and mapping. The GPSIA also includes organizations

^{1/} See Receivers and Spectrum Working Group, FCC Technological Advisory Council, “Interference Limits Policy: The Use of Harm Claim Thresholds to Improve the Interference Tolerance of Wireless Systems,” (Feb. 6, 2013) (“TAC White Paper”), *available at* <http://transition.fcc.gov/bureaus/oet/tac/tacdocs/WhitePaperTACInterferenceLimitsv1.0.pdf>. The GPSIA also submits these comments on behalf of its members Trimble Navigation Limited, Garmin International, Inc. and Deere & Company.

^{2/} See *Office of Engineering and Technology Invites Comments on Technological Advisory Council (TAC) White Paper and Recommendations for Improving Receiver Performance*, Public Notice, ET Docket No. 13-101, DA 13-801 (rel. April 22, 2013) (“Public Notice”); *Office of Engineering and Technology Extends Comment Period for Technological Advisory Council (TAC) White Paper and Recommendations for Improving Receiver Performance*, Public Notice, ET Docket No. 13-101, DA 13-1344 (rel. June 10, 2013) (extending the comment and reply comment deadlines).

representing consumers who depend on GPS for boating and other outdoor activities, and in their automobiles, smart phones, and tablets.^{3/} GPS is a highly innovative, successful, and increasingly ubiquitous technology that is critical to the smart infrastructure, services, and applications of today, tomorrow, and decades to come. It is therefore critical that, in its efforts to make more intense use of radiofrequency spectrum, the Commission not inadvertently jeopardize the reliable reception of GPS.

The GPSIA recognizes that spectrum is a scarce resource and few bands remain unoccupied today, particularly below 3 GHz, where systems and services supporting critical national infrastructure and safety-of-life uses are located. The proliferation of new technologies and applications will continue to create pressure on available spectrum.

As the Commission seeks to make more spectrum available in response to that pressure, it will be required to balance the needs of existing systems and new entrants, which will become increasingly difficult and complex. The TAC recommends that the Commission adopt an interference limits policy approach, defining a radio environment in which receivers are expected to operate, in order to address these challenges. Specifically, the TAC recommends that the Commission establish “harm claim thresholds”, *i.e.*, limits on in-band and out-of-band interfering signals that must be exceeded before a radio system can claim that it is experiencing harmful interference.^{4/} The TAC asserts that harm claim thresholds can facilitate the transition to more intensive frequency use and allow the FCC to provide guidance on the optimization of receiver performance without unduly restricting technical and consumer choice.^{5/}

The harm claim thresholds approach can be one tool for managing spectrum use

^{3/} A full list of members and affiliates can be found on the GPSIA’s website at <http://www.gpsalliance.org/about-us.aspx> (last visited July 21, 2013).

^{4/} See TAC White Paper at 3.

^{5/} See *id.* at 3.

following extensive technical analysis and acceptance. The TAC White Paper recognizes that there are many ways to address different uses of adjacent bands.^{6/} For instance, the Commission may rely on its customary transmit power and out-of-band emission (“OOBE”) rules, creation of compatible spectrum “neighborhoods,” and use of guard bands. It may also utilize a self-certification approach, under which a manufacturer would self-certify that a device is fit (*i.e.*, operates successfully and will suffer no harmful interference) for its intended use. In addition, the TAC White Paper suggests that the Commission could mandate specific receiver performance requirements (although this approach would require authority under the Communications Act).

Determining the regulatory approach depends on a number of factors, including the nature of the services in the adjacent bands and the types of receivers utilized. Indeed, as the TAC White Paper recognizes, use of harm claim thresholds may not be appropriate, or may be particularly difficult to administer, in some circumstances, such as where the adjacent services are dissimilar, the receivers utilized are “decoupled” and not controlled by the license holder, the service is not under the jurisdiction of the Commission, and safety-of-life systems like aviation and public safety are involved.^{7/}

The Commission understandably needs to consider *all* possible means of spectrum management including, on a case-by-case basis, the harm claim thresholds approach proposed in the TAC White Paper; however, because a harm claim thresholds approach has not previously been used, it requires additional analysis regarding how and under what circumstances it should be employed. In particular, the Commission should *first* encourage multi-stakeholder groups to further investigate the issues raised in the TAC White Paper (*e.g.*, identification of frequency

^{6/} See *id.* at 32-34.

^{7/} See *id.* at 3, 32-34; see also *Public Notice* at 2.

allocation boundaries, implementation choices, enforcement mechanisms, etc.). *Second*, informed by the input of the stakeholder groups, the Commission should consider whether it is appropriate to adopt a Notice of Inquiry (“NOI”) to generally determine whether to implement policies regulating interference limits and to identify circumstances in which harm claim thresholds may not be the best means to resolve co-existence issues. *Third*, based on feedback it receives from the NOI, the Commission should develop the expertise and gather data to help define harm claim thresholds and any associated transition mechanisms in circumstances in which that approach is appropriate. *Finally*, the Commission should, as part of any Notice of Proposed Rulemaking involving the new use of spectrum, determine how a harm claim threshold should be implemented in particular circumstances.

As the TAC White Paper recognizes,^{8/} the GPS industry has recently been part of the dialogue on receiver issues and looks forward to continuing to work with the Commission on these important matters.

II. THE TAC WHITE PAPER CONTEMPLATES FUNDAMENTAL CHANGES IN SPECTRUM POLICY WHICH MUST BE CAREFULLY CONSIDERED

Use of harm claim thresholds requires significant additional study, as the GPSIA recommends, because, among other reasons, it would represent an approach fundamentally different than those embodied in longstanding Commission policy. The FCC has consistently ensured that existing licensees are protected from harmful interference when new service rules are adopted and has historically placed the burden on new entrants to demonstrate that they will not cause interference.^{9/} For instance, in the 800 MHz public safety proceeding, the Commission

^{8/} See *id.* at 8 (discussing the receiver performance expectations in the LightSquared proceeding).

^{9/} See, e.g., *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands*, Report and Order, 18 FCC Rcd 1962 (2003) (imposing emission limits and other restrictions on ancillary terrestrial component operations to protect existing adjacent band services such as GPS and Personal Communications Service operations); *Globalstar Licensee LLC, Authority to Implement*

imposed the responsibility for resolving interference problems on Nextel as the transmitting party causing interference to existing public safety communications systems.^{10/} More recently, in the LightSquared proceeding, the International Bureau expressly conditioned its approval of LightSquared's proposal to provide new terrestrial-only services in satellite spectrum on LightSquared's ability to show that its operations would not cause harmful interference to GPS.^{11/} This approach is specifically intended to allow certainty in spectrum and business planning, product development, and future investment. If parties who invest in spectrum-based technologies do not have reasonable assurance that pre-existing investments will enjoy protection from unknown future interfering uses, incentives to invest in such technologies will be reduced.

an Ancillary Terrestrial Component, Report and Order and Order Proposing Modification, 23 FCC Rcd 7210, ¶¶ 31-32, 34 (2008) (requiring mobile satellite service ("MSS") licensee Globalstar to adhere to certain out-of-band emission standards in order to protect Broadband Radio Service operations); *Improving Public Safety Communications in the 800 MHz Band, et al.*, Report and Order and Further Notice of Proposed Rulemaking, 24 FCC Rcd 7904, ¶ 52 (2009) ("We emphasize that MSS entrants must avoid operation of their mobile terminals where it will cause harmful interference to BAS. If harmful interference does occur to the nonrelocated BAS incumbents from the MSS entrants, the MSS entrant must take all actions to correct the interference, up to and including curtailing operation in and around the affected markets."). A recent memorandum issued by President Obama also recognizes the need not to cause harmful interference to, and to protect, mission critical capabilities that depend on spectrum for national security, law enforcement, and safety-of-life applications, while expanding the availability of spectrum for innovative and flexible commercial uses. *See* White House Office of the Press Secretary, *Presidential Memorandum: Expanding America's Leadership in Wireless Innovation*, June 14, 2013 ("June 2013 White House Memorandum"), available at <http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovation>.

^{10/} *See Improving Public Safety Communications in the 800 MHz Band, et al.*, Report and Order, Fifth Report and Order, Fourth Memorandum Opinion and Order, and Order, 19 FCC Rcd 14969, ¶ 300 (2004) ("800 MHz Order") ("Moreover, Nextel is not only bearing the entire cost of solving the problem, but is supporting the optimal solution to the problem – band reconfiguration . . .").

^{11/} *See LightSquared Subsidiary LLC Request for Modification of its Authority for an Ancillary Terrestrial Component*, Order and Authorization, 26 FCC Rcd 566 (2011). The GPSIA recognizes that the Commission has suggested on one occasion that the responsibility for protecting services "rests not only on new entrants but also on incumbent users themselves." *Fixed and Mobile Services in the Mobile Satellite Service Bands at 1525-1559 MHz and 1626.5-1660 MHz, 1610-1626.5 MHz and 2483-2500 MHz, and 2000-2020 MHz and 2180-2200 MHz*, Report and Order, 26 FCC Rcd 5710, ¶ 28 (2011). However, the GPS industry filed a petition for reconsideration challenging this statement, which is still pending before the Commission, and, in any case, the FCC's International Bureau has rejected this position by tentatively concluding that the conditional waiver granted to LightSquared should be vacated and that its ancillary terrestrial component authority should be revoked in light of the significant concerns regarding receiver overload to GPS devices. *See* Petition for Reconsideration of the U.S. GPS Industry Council, ET Docket No. 10-142, at 7-8 (filed June 30, 2011); *International Bureau Invites Comment on NTIA Letter Regarding LightSquared Conditional Waiver*, Public Notice, 27 FCC Rcd 1596 (2012).

The harm claim thresholds approach places the burden of policing interference on existing spectrum users; however, there is no guarantee that even well intentioned new entrants working with existing users will be able to design their services and implement operations which avoid interference below a harm claim threshold. As the TAC White Paper recognizes,^{12/} the case of Nextel's implementation of mobile technology and its effects on public safety users in the 800 MHz band provides one example where parties acting in good faith still created substantial interference issues. Although the Commission ultimately decided to reconfigure the 800 MHz band, it first urged the parties to make voluntary technical changes to prevent or reduce interference at particular sites.^{13/} This approach was not successful, and the parties suggested that the Commission address interference disputes on a case-by-case basis. The Commission rejected this proposal, noting that "[a]ddressing interference on a case-by-case basis is both labor-intensive and expensive."^{14/} Relying on Commission complaint procedures to sort out widespread interference issues under a harm claim thresholds approach would likewise severely tax the Commission's resources and would likely leave interference issues unresolved for long periods of time.

A harm claim thresholds approach also departs dramatically from the expectation that the Commission has created for manufacturers of a stable spectrum environment. Manufacturers rely on the Commission to ensure that rules do not routinely change in making the investments necessary for research, development and production. The Commission has long recognized this need to ensure regulatory certainty in order to spur investment.^{15/} The Commission must

^{12/} See TAC White Paper at 56-61.

^{13/} See 800 MHz Order ¶ 14.

^{14/} *Id.* ¶ 17.

^{15/} See, e.g., *Amendment of Part 90 of the Commission's Rules to Adopt Regulations for Automatic Vehicle Monitoring Systems*, Report and Order, 10 FCC Rcd 4695, ¶ 16 (1995) (acknowledging that "uncertainty about

therefore balance the desire to facilitate flexible use of spectrum via harm claim thresholds against the risk of dissuading manufacturers from investing in the development and production of equipment that may be rendered prematurely obsolete as harm claim thresholds are adjusted based on social and economic factors. Existing spectrum users, such as the various industry segments that rely on GPS and the industry that supplies GPS-based technology, have already invested many billions of dollars in their systems to provide critical services requiring high reliability and integrity, including those used in public safety and many commercial environments.^{16/} Investments such as these would be seriously jeopardized if the Commission were to find that new entrants should be permitted to operate at increasing interference levels, shifting the costs and burdens of accommodating such operations to incumbents. The unpredictability of this regime would discourage future investment in spectrum-related enterprises. Even more troubling, a harm claim thresholds approach could also encourage parties to make risky investments based on the belief that they could persuade the Commission to continue to raise the harm claim threshold, or that they would be able to successfully delay or resist meritorious claims of interference below the harm claim threshold.

possible changes in our rules has deterred or prevented [entities] from committing greater capital or obtaining financing.”).

^{16/} See, e.g., Nam D. Pham, Ph.D., *The Economic Benefits of Commercial GPS Use in the U.S. and the Costs of Potential Disruption*, NDP Consulting, at 1 (June 2011), attached to Comments of Trimble Navigation Limited, IB Docket No. 11-109, IBFS File No. SAT-MOD-20101118-00239 (filed Aug. 1, 2011); *Sustaining GPS for National Security: Hearing Before the Subcomm. on Strategic Forces of the H. Comm. on Armed Services*, 112th Cong. at 3 (Sept. 15, 2011) (written testimony of General William L. Shelton, Commander, Air Force Space Command), available at http://armedservices.house.gov/index.cfm/files/serve?File_id=9043b110-61fa-45b9-a8ec-6c9f338981cc.

III. ANY NEW FRAMEWORK MUST REQUIRE AN INITIAL DETERMINATION OF WHETHER MODIFICATION OF PERMITTED OPERATIONS IN A SPECTRUM BAND TO SUPPORT FLEXIBLE USE, VIA HARM CLAIM THRESHOLDS OR OTHERWISE, IS IN THE PUBLIC INTEREST

A. The Commission Must Balance the Benefits of a Harm Claim Threshold Approach Against the Costs to Legacy Users and Potential Degradation of Service and Loss of Innovation.

The TAC White Paper focuses on the goal of maximizing the amount of “flexible use” spectrum stating that “[t]o meet the rapidly increasing demand for wireless capacity, wireless systems must operate in ever closer proximity in frequency, space and time.”^{17/} While not expressly defined, “flexible use” as described anecdotally in the TAC White Paper contemplates cellular network architectures with the operational characteristics that accompany cellular networks – very high-power base stations communicating with portable or handheld devices.^{18/} The TAC White Paper suggests that a flexible use model can be implemented and high-power spectrum uses can be introduced in adjacent bands to preexisting uses over time through the progressive modification of harm claim thresholds. Specifically, by increasing the permissible power flux density in adjacent bands to incumbent services, the TAC White Paper anticipates incumbent users will be able to implement sharper filtering and other complementary hardware modifications to prevent the stronger unwanted adjacent signals from affecting the receiver while still enabling reception of the desired legacy signal.^{19/}

The TAC White Paper, however, does not provide any detailed discussion of the technical and logistical issues involved with respect to the development and implementation of a harm claim threshold, or any framework for determining when harm claim thresholds may be

^{17/} TAC White Paper at 5.

^{18/} See, e.g., *id.* at 13 (explaining that licensees should assume “as a starting point that the adjacent band will be re-allocated for use as a cellular downlink”).

^{19/} See *id.* at 9.

appropriate to bring about a transition in spectrum use. Before moving forward with a harm claim threshold approach, the Commission must first make a determination of compatibility and feasibility on a band-by-band basis regarding the benefits of flexible use versus the operational impact and costs of raising the power flux density level in a band adjacent to an incumbent spectrum user.

With respect to weighing the benefits of implementing a harm claim threshold in a particular band(s), the GPSIA urges the Commission to assess carefully the compatibility with incumbent spectrum uses and consider other relevant factors, including the following:

Costs of replacing or modifying the installed base of incumbent user equipment: The costs of hardening existing equipment to tolerate stronger signals in adjacent bands may be prohibitive. In some instances, it may be impossible or impractical to retrofit hardware, which may need to be retired and replaced well before the end of the equipment's useful life. In such situations, users may suffer significant lost investments that cause economic and market harms contrary to the public interest.

Costs to develop compliant devices without sacrificing performance and innovation: Significant research and development expenditures in the form of man hours and capital expense will be needed to determine if a device can be developed that complies with a proposed harm claims interference threshold without sacrificing performance relative to existing equipment and then to design and manufacture that device.

Decreased functionality of devices that comply with new requirements: It may be incorrect to assume that redesigned receivers will tolerate stronger signals in adjacent channels and permit a different class of adjacent channel use without any loss of performance or functionality. For example, sensitive receivers that by design capture faint signals (*e.g.*, radioastronomy) may experience a degradation in performance if they are forced to tolerate markedly stronger adjacent channel signals, even if they are completely redesigned.

Balancing the benefits of harm claim thresholds against the cost of replacement, research and development expenditures, and decreased functionality of upgraded legacy devices is an analysis that will need to occur every time the Commission wishes to impose (or adjust) a harm claim threshold. In particular, the Commission will need to conduct a rigorous compatibility and feasibility analysis, including a cost-benefit analysis weighing the introduction of a new service

against the engineering, economic, and social costs of disrupting existing services, including potential loss of performance and limitations on innovation.

B. The Commission Should Carefully Consider the Concept of Broadly Defined “Flexible Use” and Not Simply Equate Highest and Best Use With Current Technology.

The emphasis in the TAC White Paper on facilitating “flexible use” and the association of this concept with high-powered cellular-based systems presumes that current technology for delivering mobile broadband will be used into the indefinite future.^{20/} Accordingly, if a flexible use framework is introduced by the Commission in a band, users of adjacent bands must assume that ultimately the use of the band will be high-powered cellular use.

This approach is short-sighted and unwise. Creating an assumption that all spectrum may ultimately be used in a high-power cellular architecture may impose significant costs for existing spectrum users who may be compelled to modify or replace equipment, or may result in a degradation in the utility of the band for existing users if retrofitted and/or new equipment does not perform as well as existing hardware with respect to the intended function of the band. Moreover, the costs and effort associated with preparing for a cellular-based network in adjacent spectrum may be unnecessary if technology preferences change or the ultimate adjacent spectrum user develops an alternative technology or business model. An assumption that all spectrum may ultimately be used for high-power cellular networks also overlooks that all spectrum uses may not be able to accommodate that use in adjacent bands. The Commission must more thoroughly analyze whether it will be technically feasible for some services to reasonably accommodate high-power cellular use in adjacent bands.

^{20/} See, e.g., *id.* at 36 (discussing Kwerel & Williams recommendation that flexible use be defined as “a dense deployment of base, mobile and fixed transmitters operating at fully functional power levels typical of a modern wireless cellular architecture”); see also Kwerel, E. and Williams, J., “Solving the Receiver Problem Without Receiver Standards: FCC Workshop on Spectrum Efficiency and Receivers,” March 13, 2012, *available at* <http://transition.fcc.gov/bureaus/oet/receiver-workshop1/Session6/SESSION-6-1-Kwerel-Williams-FCC.pdf>.

There are many examples of very successful spectrum uses with very different technical characteristics, such as GNSS, direct-to-home satellite video, satellite radio, and low-powered unlicensed applications, which are among the most ubiquitous spectrum uses. Given the lack of a technological “crystal ball,” a presumption that every service should be required to accommodate flexible use in the form of mobile broadband in adjacent bands is unsound and should not be adopted.

IV. IF IMPLEMENTED, HARM CLAIM THRESHOLDS SHOULD BE ONLY ONE OF THE COMMISSION’S TOOLS FOR ACHIEVING MORE EFFICIENT AND INTENSIVE SPECTRUM USE

A. If Implemented, Harm Claim Thresholds Should Be Considered Only in Specific Circumstances.

To the extent the Commission continues to investigate the viability of harm claim thresholds as a spectrum management tool to increase spectrum utilization, the GPSIA asks the Commission to recognize the limitations of this approach and define reasonable parameters to ensure that the approach is only used when the circumstances are appropriate. Specifically:

Adjacent Services Should Be Relatively Similar: Harm claim thresholds may be a useful spectrum management tool between bands supporting similar services (*e.g.*, abutting cellular bands or fixed satellite bands), when power levels are comparable and known use models enable engineers knowledgeable in the respective bands to evaluate likely interference levels with a high degree of certainty.

The Commission should avoid placing services with significantly different technical parameters immediately adjacent to each other and relying on a harm claim threshold to try to avoid incidences of harmful interference. In real world environments, it is impractical to place highly sensitive receivers designed to capture faint signals from remote transmission sites in spectrum immediately adjacent to spectrum used by high-power base stations without

maintaining meaningful physical separation. One current example of the very significant challenges of locating disparate uses directly next to each other is illustrated in the 600 MHz band plan deliberations in which the Commission is currently contemplating a mid-band gap guard band between base station downlink bands and handset uplink bands.^{21/}

The Commission Should Have Regulatory Authority Over Both Adjacent Bands: Harm claim thresholds may be appropriate spectrum management tools when the Commission exclusively regulates both of the affected adjacent bands (*i.e.*, the legacy band where the threshold will be applied and the immediately adjacent band where flexible use will be promoted). For example, the adjacent 600 MHz cellular band and 700 MHz cellular band where the Commission has regulatory authority over both sides of the spectrum boundary and has deep knowledge regarding the service rules and authorized equipment approved for each band might be a suitable opportunity to implement a harm claim threshold.

The Commission should avoid attempting to apply harm claim thresholds to bands that it does not regulate, including the 1559-1610 MHz GNSS band, which supports the GPS L1 signal. The National Telecommunications and Information Administration (“NTIA”) retains jurisdiction over bands held by the federal government and should continue to determine the appropriate interference levels for applications in such spectrum.^{22/} Protection of GPS is a defined goal of United States policy and other national and international regimes and the subject of international

^{21/} See *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Notice of Proposed Rulemaking, 27 FCC Rcd 12357, ¶¶ 166-167 (2012) (“600 MHz NPRM”).

^{22/} See 47 U.S.C. § 901(c) (directing NTIA to advance policies that “foster[] full and efficient use of telecommunications resources, including effective use of the radio spectrum by the Federal Government, in a manner which encourages the most beneficial uses thereof in the public interest”); 47 U.S.C. § 305 (delegating to NTIA the authority “to assign frequencies to radio stations or classes of radio stations belonging to and operated by the United States”).

treaties.^{23/} The recent Presidential memorandum on “Expanding America’s Leadership in Wireless Innovation” reiterates the need to protect such safety-of-life services, many (perhaps most) of which are enabled by GPS.^{24/} It is not appropriate for the Commission to unilaterally determine these spectrum “rights” for the GNSS band by applying a harm claim threshold to adjacent private use bands.

Bands in Which Equipment Has a Long Lifespan and Is Deeply Embedded are Not Appropriate for Harm Claim Thresholds. A harm claim threshold is an approach more appropriately considered for bands in which the equipment utilized has a relatively short lifespan and is not part of a complex, expensive system which would be costly and onerous to disturb. Even if the Commission had jurisdiction over the radionavigation bands that support GPS-based equipment, which it does not, the extremely long useful life of GPS receivers and the complexity of the systems of which such equipment is a part would make it exceptionally onerous and disruptive to implement a harm claim thresholds approach for GNSS/GPS bands. Aviation equipment can take more than a decade to develop and certify and is frequently in use for decades.^{25/} Military equipment procurement and utilization cycles are very prolonged.^{26/}

^{23/} See, e.g., White House, National Security Decision Directive Number 102, *U.S. Response to Soviet Destruction of KAL Airliner*, Sep. 5, 1983, available at <http://www.fas.org/irp/offdocs/nsdd/nsdd-102.htm>; White House, National Security Decision Directive Number 6, *U.S. Global Positioning System Policy*, March 28, 1996, available at <http://www.fas.org/spp/military/docops/national/gps.htm>; White House, Presidential Policy Directive Number 4, *National Space Policy of the United States of America*, June 28, 2010, available at http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf.

^{24/} See generally June 2013 White House Memorandum.

^{25/} See *Garmin Presentation at FCC Workshop on Spectrum Efficiency and Receivers*, at 8 (Mar. 13, 2012) (written presentation of John Foley, Director of Aviation GNSS Technology, Garmin), available at <http://transition.fcc.gov/bureaus/oet/receiver-workshop1/Session3/SESSION-3-3-Foley-Garmin.pdf>; *GPS Reliability: A Review of Aviation Industry Performance, Safety Issues, and Avoiding Potential New and Costly Government Burdens, Before the H. Transportation and Infrastructure Comm.*, 112th Cong., at 18 (June 23, 2011) (written testimony of Philip Straub, VP, Garmin), attached to Letter from M. Anne Swanson, Dow Lohnes, Counsel to Garmin, to Marlene H. Dortch, Secretary, FCC, IBFS File No. SAT-MOD-2010118-00239 (filed June 27, 2011) (“Garmin Letter”); *GPS Reliability: A Review of Aviation Industry Performance, Safety Issues, and Avoiding Potential New and Costly Government Burdens, Before the H. Transportation and Infrastructure Comm.*, 112th Cong., at 6 (June 23, 2011) (written testimony of Margaret Jenny, RTCA), attached to Garmin Letter.

Professional use GPS equipment such as survey equipment may be in use for up to ten years. Sophisticated agricultural equipment is designed to last for many seasons. Even consumer equipment, such as marine navigation devices, is commonly in use for similar periods. In light of the lengthy potential transition periods and disruption involved in accommodating incompatible uses of adjacent spectrum next to costly, complex and sensitive services through implementation and adjustment of harm claim thresholds, the Commission, in such instances, should consider whether long-term refarming of spectrum, such as relocating and consolidating compatible, low-power uses to a “quiet spectrum neighborhood” would better serve the public interest.

B. Other Spectrum Management Approaches Will Be Appropriate in Different Circumstances and Should Not Be Overlooked by the Commission.

The Commission must not overlook the alternative spectrum management tools at its disposal to help meet its goal of increasing spectrum efficiency and enabling wireless systems to “operate in ever closer proximity in frequency, space and time.”²⁷ For example:

Spectrum Zoning: A “zoning” approach may be most appropriate to minimize conflicts between dissimilar services, particularly in cases when one is a communications service, and the other is not. Not all services utilize high power levels; a zoning approach can avoid the use of harm claim thresholds, for example, if low-power services are grouped together.

^{26/} See *Sustaining GPS for National Security: Hearing Before the Subcomm. on Strategic Forces of the H. Comm. on Armed Services*, 112th Cong. at *11 (Sept. 15, 2011) (oral testimony of General William L. Shelton, Commander, Air Force Space Command), available at http://findarticles.com/p/news-articles/political-transcript-wire/mi_8167/is_20110916/rep-michael-turner-holds-hearing/ai_n58165676/ (explaining that it would take a decade or more to test and implement new equipment); see also Letter from James A. Kirkland, Vice President and General Counsel, Trimble, to the Honorable Michael Turner, Chairman, Strategic Forces Subcommittee of the House Armed Services Committee, and the Honorable Loretta Sanchez, Ranking Member, Strategic Forces Subcommittee of the House Armed Services Committee, at 15-18 (Oct. 6, 2011), attached to Letter from Russell H. Fox, Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C., Counsel to Trimble, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 11-109 (filed Oct. 7, 2011)

²⁷ TAC White Paper at 5.

Radionavigation, radioastronomy, etc. have unique needs.^{28/} The same filters employed for communications applications may not be compatible for such alternative, non-communication applications, or may involve design tradeoffs that reduce the effectiveness or utility of the receivers.

Guard Bands: The TAC White Paper incorrectly concludes that guard bands allow spectrum users to employ “filters that stretch into the guard bands, thus ‘using’ frequencies they have not had to obtain.”^{29/} First, the TAC White Paper overlooks other important reasons for implementing guard bands, including the need in some instances to create a buffer between noisy transmitters prone to high levels of out-of-band-emission (*e.g.*, LTE handsets which are prone to RF splatter) and neighbors. Second, it is patently wrong to assert that guard bands allow filters to use spectrum that the end user did not “obtain.” A guard band helps create a known, stable spectrum environment in which both transmitters and receivers can make full use of the spectrum allocated to them instead of implementing exotic or impractical technology to create a “brick wall” between adjacent bands. Accordingly, the Commission cannot and should not dismiss out of hand the possibility that guard bands will be required when highly dissimilar uses are located in adjacent spectrum. It is already very clear that the 600 MHz band plan, in whatever form ultimately adopted, will require guard bands between dissimilar services.^{30/}

As a general matter, in dismissing guard bands, the TAC White Paper simply assumes, without providing technical evidence, that with the right amount of time and some unknown level of investment in new technology or alternative product design, any spectrum use should be

^{28/} The receivers used in these and other non-communications services have distinct characteristics. For example, radionavigation receivers by design capture a wider bandwidth signal than communications receivers to improve accuracy.

^{29/} TAC White Paper at 12.

^{30/} *See 600 MHz NPRM* ¶¶ 166-167

able to accommodate high-powered, cellular-like operations in directly adjacent spectrum. This assumption needs to be thoroughly tested and validated. Based upon the number of past instances in which dissimilar uses in close spectral proximity have created significant interference issues, ample reason exists to question whether this assumption is correct, or would be correct in all cases. If there is doubt on this point or the assumption is incorrect, adoption of a “zoning” and re-farming approach, which groups similar uses together (*e.g.*, low-power and satellite uses) could actually reduce the need for guard band spectrum between dissimilar uses by minimizing the number of band “edges” between dissimilar uses.

C. Geolocation Databases, Sensing, and Other Sharing Techniques Merit Further Exploration, But May Not Always Be Appropriate.

The Commission is considering geo-location databases, sensing, and other sharing techniques that can help create temporal or physical separations. The GPSIA believes that in some bands these techniques may yield tremendous gains in spectrum reuse and efficiency; however, while such methods may be helpful in particular circumstances, they are not appropriate for services that are inherently mobile; nor are they suited for ubiquitous services like GPS that must operate in all locations. Some 500+ million GPS receivers roaming the nation cannot be accurately reflected in a geolocation database, and, given that GPS receivers do not generally have a transmit feature, spectrum sensing technologies are not effective with GPS.

V. HARM CLAIM THRESHOLDS PRESENT SPECIFIC METHODOLOGICAL ISSUES AND PORTEND SERIOUS ADMINISTRATIVE DIFFICULTIES THAT MUST BE ADDRESSED

The TAC White Paper itself acknowledges that the application of harm claim thresholds may require special consideration in certain situations, including, in particular, instances involving “life-safety systems like aviation and public safety” and cases in which “receivers are

not controlled by a license holder.”^{31/} As shown below, the GPSIA’s recent experience has borne this out, demonstrating that probabilistic methods for determining interference, like harm claim thresholds, raise special concerns since they are subject to varying interpretations. Probabilistic models also present difficult issues for non-communications services like GPS which operate below the noise floor and, as the TAC White Paper acknowledges, utilize “decoupled” devices unrelated to any licensee or carrier that might help implement a harm claim thresholds regime. These challenges and difficulties are likely to be magnified when innovation outpaces the standards and assumptions embodied in harm claim thresholds. All told, these various issues may make implementation of harm claim thresholds administratively taxing, if not impossible.

A. Harm Claim Thresholds Are Problematic for Non-Communications Technologies Such as GPS.

GPS is a navigation system and operates differently than radio communications systems. The primary measurement in GPS is the timing of bit transitions in the navigation signal. Precise positioning requires sub-nanosecond measurement of bit edges. Accurate measurement of bit edges in turn requires wide receiver bandwidth, and effective multipath rejection also requires wideband signals. Consequently, filtering for GPS receivers must be carefully designed so as not to disrupt these bit edges. Thus, precise determination of peak interference power levels is essential to determining effects on navigation systems. Also, unlike communications systems which operate above the noise floor, spread spectrum GPS signals are below the thermal noise floor at the point when they are received. The cumulative effects of in-band interference can easily increase the noise floor and degrade performance. Given these differences, there are

^{31/} TAC White Paper at 3.

fundamental questions as to whether it would be practical to implement harm claim thresholds, based on probabilistic models, for determining interference to navigation systems.

It is likewise important to recognize that the noise floor can be increased by both in-band and out-of-band sources, including multiple licensees in adjacent bands. As a result, the origin of an increase that exceeds a harm claim threshold may not be clear – and, therefore, not identifiable. Similarly, since the noise floor is by definition an aggregation of noise from multiple sources, the FCC, if it tries to implement a harm claim thresholds approach, will likely be unable to determine which contributor is “responsible” for a change in the noise floor and obliged to modify its operations. These significant sources of uncertainty make a harm claim thresholds approach extremely unworkable in the navigation context.

In light of these problems, adoption of a harm claim thresholds approach would likely have the adverse effect of channeling innovation solely toward operation in noisier RF environments, rather than toward lower-power transmission services operating with higher sensitivity receivers. In the long run, increases in the noise floor could render the RNSS bands inoperable for navigation and location-based services, technologies, and systems. Precise and stringent receiver protection criteria, such as those applied in the aviation industry, will allow new services based on navigation – such as driverless cars and truck fleets – to grow and flourish.

B. Probabilistic Methods for Determining Interference Are Subject to Varying Interpretation and Can Fail To Provide the Certainty Required in Regulatory Environments.

Over the last eighteen months, various federal agencies and the GPSIA have had direct experience in evaluating the utility of probabilistic interference modeling approaches in gauging the effect that a new proposed service may have on another service’s existing operation. The

experience has proven traditional modeling approaches used for communication systems to be deficient for GPS-based navigation systems.

From mid-2011 to early 2012, the FAA undertook a thorough analysis, at the cost of several million dollars, of the potential effect on GPS-based avionics equipment and aviation safety of a new high-powered terrestrial broadband service proposed by LightSquared.^{32/} In its report, the FAA specifically noted that it was unable to identify a mutually agreeable interference model that would give it any confidence that LightSquared's proposed service would not pose a danger to aviation safety: "Since the FAA and LightSquared have not identified a general propagation model suitable for all facets of the necessary analysis, it is then not possible to agree on the aggregate LightSquared signal interference levels."^{33/}

Lacking a probabilistic model that could adequately account for all likely scenarios, the FAA found the alternative – case-specific analyses – administratively impossible and an endless exercise in trying to establish compliance:

Implementation of the most recent LightSquared proposal would still require an extensive site-by-site analysis, taking into account local topology, building/obstruction morphology, aircraft operations, and LightSquared ATCt deployment. Any future changes, *e.g.*, new runway or area navigation approach or new LightSquared tower, would then require revisiting the analysis and potentially require changes to LightSquared's operating parameters for the ATCt sites in the area of impacted aviation operations. These activities would indirectly become an open-ended compliance process issue with no defensible end-date.^{34/}

The FAA's conclusion underscores that, in certain situations and with certain services, site-by-site analysis is critical because many probabilistic models make assumptions that average

^{32/} U.S. Dept. of Transportation, Federal Aviation Administration, "Status Report: Assessment of Compatibility of Planned LightSquared Ancillary Terrestrial Component Transmission in the 1526-1536 MHz Band with Certified Aviation GPS Receivers," Jan. 25, 2012 (redacted version cleared for public release), *available at* <http://apps.fcc.gov/ecfs/document/view?id=7021860338>.

^{33/} *Id.* at 67.

^{34/} *Id.*

out peak power levels, an unacceptable approach for navigation services like GPS; moreover, the dynamic nature of both a new service, such as LightSquared's, and established navigation systems make it inherently difficult to model such an environment on a probabilistic basis.^{35/} In short, the FAA concluded that "[t]he variations in local propagation environments preclude[d] adoption of any readily implementable mitigation for this interference."^{36/}

In a somewhat related context – analysis of LightSquared's "power on the ground" model for mitigating interference, the U.S. GPS Industry Council, the precursor to the GPSIA, pointed out that use of probabilistic path loss models, such as those proposed by LightSquared, that only model the average power levels a user would expect to see on the ground, are inappropriate because of the variations in path loss that can be observed at any given site.^{37/} Because the power-on-the-ground proposal relied on average power levels rather than peak power levels for GPS interference analyses, it "virtually assure[d] that the actual peak power-on-the-ground, and the GPS interference, will be far greater than allowable limits even before [any] on-the-ground sampling begins."^{38/}

Services that implicate safety-of-life concerns will always require appropriate margin calculations and different analytical tools such as free space path loss models. In these situations, the cost of inaccurate modeling that fails to account accurately for real-world data is much too high to justify any administrative simplicity or conformity that may come from modeling regimes.

^{35/} *Id.* at iii.

^{36/} *Id.* at ii.

^{37/} Letter from F. Michael Swiek, USGPSIC, to Marlene H. Dortch, Secretary, FCC, IBFS File No. SAT-MOD-20101118-00239 and IB Docket No. 11-109, at Attachment A, at 2 (filed Nov. 9, 2011).

^{38/} Letter from F. Michael Swiek, USGPSIC, to Marlene H. Dortch, Secretary, FCC, IBFS File No. SAT-MOD-20101118-00239 and IB Docket No. 11-109, at Attachment, at 1, 2 (filed Jan. 26, 2012).

C. “Decoupled” Devices Present Special Challenges for Implementation of Harm Claim Thresholds.

As the TAC White Paper acknowledges, implementing a harm claim thresholds approach for “decoupled” devices, like GPS receivers, would present difficult, if not insurmountable, challenges. GPS devices receive signals directly from satellites. While satellites are subject to FCC regulation, GPS receivers are divorced or “decoupled” from FCC licensing and from any centralized data collection process or mechanism. Unlike with mobile carriers that regularly take signal measurements in the ordinary course of their business, there is no central source or obvious mechanism for collecting such data for “decoupled” devices.

The resulting administrative problems are clear. Millions of devices are and will continue to be in the hands of businesses and consumers, but no entity or individual will be in a position to collect or have responsibility for collecting data and then prosecuting complaints for violation of harm claim thresholds. Mandating harm claim thresholds poses a substantial likelihood that large companies using spectrum as a key part of their businesses will be favored at the expense of “decoupled” or decentralized spectrum uses. Over the years, many innovations have come from such decentralized uses and users, including FM radio and satellite weather, and the adoption of harm claim thresholds presents the risk of suppressing their innovation. Service providers will not invest in innovative new products if they are responsible for recalling or retrofitting them when the Commission determines to adjust an adjacent band’s harm claim threshold.

D. As Technology Advances, Harm Claim Thresholds and Their Underlying Assumptions May Obsolete, Making Objective Dispute Resolution Difficult.

Adoption of any administrative standards is time consuming and resource intensive. In implementing a harm claim thresholds approach, the Commission will need to analyze and approve certain objective standards and measures, which presumably will remain in place for a

period of years. Adoption of these standards will be based on various assumptions at that time related to technological feasibility, physical limitations, and implementation costs. As technology evolves, however, harm claim thresholds and their underlying assumptions may not keep pace with innovation and may become obsolete. Such technological changes will create new ambiguities in the application of harm claim thresholds, uncertainties that may prevent objective resolution of future disputes. Such administrative difficulties and substantive dislocations will likely diminish any utility that harm claim thresholds may have provided when they were first adopted. Their use is particularly questionable in dynamic and innovative technological fields.

VI. CONCLUSION

In considering the TAC's White Paper and the harm claim thresholds approach, the GPSIA respectfully requests that the Commission take the actions outlined above. Such efforts will address the need for additional spectrum to support the growth of the mobile broadband market while ensuring that critical services such as GPS remain protected.

Respectfully submitted,

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